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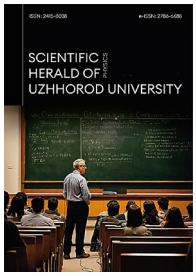

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Pedagogical methods of professionally-oriented training of medical faculty students in the field of medical biophysics

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Abstract

Relevance. The higher education system is primarily founded on pedagogical goal-oriented processes which are closely logically connected. These processes enable to teach specialists fundamentals-based and clinical knowledge, fully-applied theoretical and professional skills and train them to conduct research work and to independently enhance their knowledge. These are the first principles of training future specialists.

Purpose. This article aims to examine the pedagogical methods of teaching medical technologies for specific purposes in the discipline "Medical Biophysics" at medical higher education institutions.

Methodology. The analysis of the curriculum and textbooks on the disciplines "Internal Diseases", "Surgical Diseases", "Diseases of Children", and "Obstetrics and Gynecology" studied by the students of the 3rd-5th years of medicine faculty was conducted during the work.

Results. From the results of the research it follows that the majority of diagnostic methods observed in the clinical disciplines for senior students are based on physical phenomena and laws, and these findings should be taken into consideration in teaching physics for specific purposes.

Conclusions. The research highlights the importance of teaching physics to medical students. By focusing on the application of physical phenomena in medicine, diagnostics, and medical equipment, students are motivated to study physics.

Keywords: medical equipment; pedagogics; diagnostics; biopotential; training program.

Introduction

The prosperity of each state is not measured by its mineral resources such as iron, oil, coal, gas and etc., its main dignity is people's health. Accordingly, the state adopted various programs and measures to improve the health of the national population and transferred it for implementation to relevant ministries and organizations. Fulfilling these purposes is one of the most important functions of health care staff, doctors in particular. From this perspective, the training of students (future doctors) of medical faculty in higher education institutions that meets all requirements of the modern society, competitive in market relations, has major state and social importance. Generally, the education system should be considered as the processes of pedagogical education, which are systematically interconnected. These processes enable to train the specialists fundamental, basic and clinical sciences, allow students to master theoretical knowledge and professional skills on the specialty, to carry out research work and to independently improve their

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qualification. These are the most significant concepts of training future specialists.

In this article, we examine the pedagogical methods of teaching the discipline "Medical biophysics" in medical higher education institutions. The main objectives of teaching the medical course of physics in medical higher education institutions are generally based on the characteristics of doctor qualification and programs of the special clinical disciplines illustrated in the curriculum of the higher medical education of the Republic of Kazakhstan. Moreover, according to these programs, the students-future doctors are offered to study the effects of physical factors on a human body, to use them in the diagnostic, therapeutic, clinical laboratory practice, to work with the equipment and consider it as the main direction of professional assimilation, at the same time acquiring the basic fundamental laws and principles of medical physics.

A.A. Utepbergenov and N.I. Gubanov [1] were the first academicians of Kazakhstan who taught the discipline "Biophysics" in the sphere of medicine. Consequently, "Medical biophysics" and biophysical phenomena were further analyzed and discussed in relation to medicine. In recent years the researches have been conducted in the area of training the physics at educational level for the higher education students in the professional direction. Among the researches conducted, we should mention the following works: "Formation of the general experimental abilities of medical students in the process of studying of physics" by N.G. Arzumanyian [2], "Realization of the principle of a professional orientation in physics in medical higher education institutions" by E.L. Riazanova [3], "Formation of professional competences of future doctors in the course of physical experiment in the medical higher education institution" by S.A. Surovikina [4], "Methods of realization of value and semantic orientations of students when studying medical and biological physics" by O.E. Akulich [5], "Training for the solution of professional tasks of students of medical higher education institutions, when teaching physics in view of cross-disciplinary integration" by A.N. Biriukova [6]. In this direction, foreign scholars have also conducted their researches offering the innovative ways of student's active mastering the Physics [7; 8]. Pedagogical researches of this direction were conducted by the teaching staff of higher education institutions of the Republic of Kazakhstan [9; 10]. These researches imply the mastering of U. Baizak Medical Faculty students the use of medical equipment, as presented in the work of B. Ualikhanova [11] in the field of professional teaching of medical biophysics.

Now, we should consider professional education and professional training. There are different opinions in pedagogical researches and literature concerning these concepts. For example, Yu.K. Babansky [12] stated that: "... professional and specialized education is a certain amount of education, ability and skills in the sphere of a specialty...", A.M. Novikov [13] regards it as a factor of "...influence on a personality in the formation of a specialist as a result of training and education...".

Clearly, there are a lot of experts' views on "professional training", but they largely concern the future teachers. For example, V.A. Slastenin [14] discovers that the achievement of a high level of training depends on the pedagogical ability and skills. S.S. Mausymbayev [15] has defined the theoretical bases of future teachers' professional training in the subject of Natural Sciences. In recent years the problems of development of students' competence in the mastering the subject of Physics at medical schools have been comprehensively investigated. These researches suggest that students acquire the knowledge in biophysics in the framework of their future profession [16]. All the researchers during their studies came to the following conclusion: "... professional training is an acquisition of special knowledge, it gives opportunities to perform certain tasks, activities and apply skills" [17].

U.A. Baizak is one of the first scholars [18] who has conducted his research on professional education in the medical equipment science and professional training of future doctors in the Republic of Kazakhstan. He reached a conclusion that the professional education is "... an activity and the special knowledge of future doctors, that gives them the chance to perform their professional tasks in the sphere of health care and professional training completely and productively", he emphasized that the professional training "… is the ability to apply all the acquired specialized knowledge and experience for certain purposes" (diagnostic, therapeutic, clinical laboratory researches). Analyzing the above-stated researches, we should note that professional training of students of medical higher education institutions in biophysics is the "development of biophysical knowledge, meeting the requirements of standards of the higher medical education and health care spheres", and the professional training of students of medical higher education institutions is "a set of activity and ability of applying knowledge in clinical researches."

Materials and Methods

The modern medicine is considered as a multistage diagnostic and therapeutic process on identification and elimination of the causes and symptoms of a disease. This process includes the main stages of collecting clinical data, their analysis, decision-making and medical treatment. In many cases, during the determining the causes and treatment of a disease the doctor uses not only the accumulated knowledge and experience, but also the data of diagnostic and therapeutic medical equipment, factors of physical treatment, i.e., the practice of the modern doctor cannot be considered separately from using various medical equipment. According to the foreign researches, doctors use the data of medical equipment of diagnostics and treatment in 25-40 % of cases, irrespective of the level of knowledge and qualification. According to Russian researchers, 80 % of patients of hospital in-patient department, 60 % of patients of out-patient department, and all patients in health resorts need physiotherapeutic treatment provided by means of medical equipment [19]. It proves that diagnostics and treatment depend on the medical technologies, medical equipment takes a specific place in medical institutions, educational and research works, as well as in other medical spheres.

In view of the revealed questions, it is necessary to pay attention not only to specific training in different physical phenomenon in the discipline "Medical Biophysics" of students, but also to the use of these physical phenomena in diagnostic equipment considered in the clinical disciplines of other courses. In the modern world medicine,

there is such concept as the science of integration, which is closely connected to achievements of natural sciences, developing on the basis of scientific discovery. There are a lot of examples proving that all physical phenomena in the science of physics are connected with the development of medicine. The complex of all physical phenomena of nature, applied in diagnostics and therapy, is called a complex of all the physical factors. The concept of physical factors is widely applied in medicine. For example, V.S. Ulashchik [20] and other researchers paid significant attention to the impact of harmless physical factors with no allergic and collateral effects on the human body. Physical factors are widely applied in some medical equipment (diagnostic and therapeutic), for this reason we have focused on physical factors and its application in medicine.

Analyzing all these scientific views we are able to conclude that professional training of students of medical faculty is a multiple-factor phenomenon, i.e. training of the qualified professional medical specialists that meets the requirements of the time and the society adapted to market relations, mastering the fundamentals of science, education and medicine, depends on the following factors: standard of the state medical education, content of the disciplines of standard educational program, textbooks, material condition of a higher education institution, academic teaching staff, requirements of the society and market relations, motivation, psychological condition, cognitive activity and so forth. To sum up, we propose the model of training physics for students of medical higher education institution, as illustrated in Figure 1.

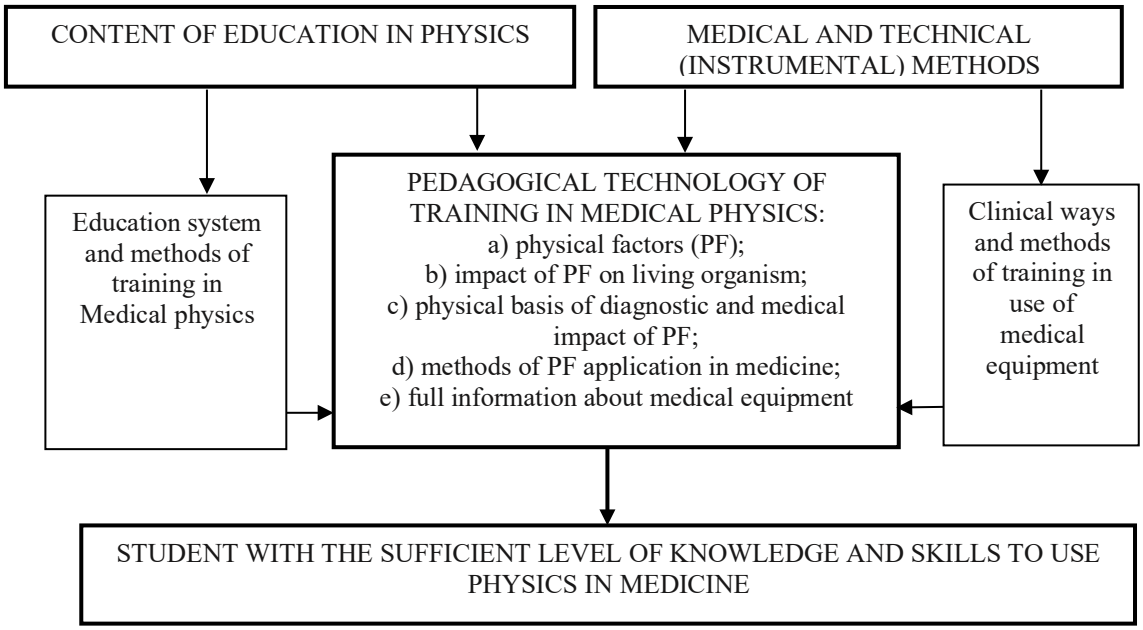

Figure 1. The model of professional training discipline "Physics" for higher education institution students

Results

Studying the pedagogical problems of professional training of medical students, analyzing the standards of medical higher education in Kazakhstan, the standard programs and textbooks of medical biophysics and clinical disciplines, as well as having examined the experiences of some higher education institutions, we revealed the following disadvantage: the textbooks, according to the standard training program on medical biophysics, comprise an unilateral description of a variety of physical phenomena and principles, giving only recommendations, but application of the phenomena and principles in diagnosing and treatment of the diseases and in instruction in medical equipment are not specified in clinical subjects. It causes the complication of the professional training of future doctors, and does not correspond to pedagogical purpose. The next psychological moment should be noted here. If the students are certain that the studied physical phenomenon of medical physics has a direct bearing on medicine, then they are interested in deep study of this subject, it is a pedagogical factor which implies an increase in the student's progress. Therefore, we examine the "pure" physical concepts and principles described in textbooks on medical biophysics and we define the necessity of teaching them in the course of corresponding clinical disciplines.

In order to implement the afore objectives, we have observed the clinical disciplines of standard programs and the use of various physical phenomenon, specified in the textbooks and offered according to the standard program, more precisely used in the diagnostic purposes. To this end, we analyzed the curriculum and textbooks [21-29] on the disciplines "Internal Diseases", "Surgical Diseases", "Diseases of Children", "Obstetrics and Gynecology" studying by the students of the 3rd-5th years of medicine faculty in the specialty 5B301100 "General medicine". Our aim was to prove the application of different physical phenomena in clinical disciplines and textbooks and the methods used in medicine particularly for revealing various diseases. The results of the researches are presented in Table 1.

Table 1. Application of different physical phenomena in diagnosing

No.	**Diagnostic methods used in the textbooks (diagnostic practice)**	**Physical phenomena used in diagnostics**	**Explanation of diagnostic inferences in the framework of physics**
1	Pneumonia of lungs is defined with auscultation.	Turbulent flow	The effect of pathology results in the narrowed bronchial tube of lungs, therefore occurs the turbulent flow, subsequently loud or small sound is heard from the lungs.
	Diagnostics of cardiac disease resulted from lungs disease using the cardiophonography.		Diagnose is defined by the record of the sound coming from blood flow.
	Examination of heart condition using the echocardiography.		Tone of the sound from heart changes, which defines the heart condition.
2	Defects of the bronchial valves are defined with cardiophonography.	Physical characteristics of the sound (pitch of tone, loudness, tone, timbre, murmurs)	I and II tones of the sound are changed which is heard by using cardiophonography.
	The work of children's heart is examined with cardiophonography.		Heart function is defined by changes of heartsound tone.
	The fetal heart rate from the uterus is measured with cardiophonography.		Heart rate is measured by heartsound tone.
3	Tumour of mammary gland with a diameter up to 0.5 cm is defined with ultrasonography.	The characteristics of dispersion of ultrasound wave on various tissues.	Ultrasound of 7-10 MHz penetrates through low resistance.
	Ultrasonography of gall bladder.		Enlargement of the gall bladder and thickening of its walls change the reflection ultrasound wave.
	The type of stomach cancer is defined with ultrasonography.		Level of reflection of ultrasound wave form various tissues differs.
	Parasitic diseases such as echinococcosis and others are defined with ultrasonography.		Under the influence of the echinococcus, liver density is changed, which changes the reflection of ultrasound wave.
	Volumetric measurements of heart and blood vessels of children are defined with ultrasonography.		Level of reflection of ultrasound wave from border of the various tissues is different.
	The condition of the bronchus of children is defined with ultrasonography.		Intensity of the reflection of ultrasound wave from the different tissues is different.
	Diagnostics of pericardial effusion.		Fluid in the pericardial cavity is noticeable by ultrasonography, the reflection level from the fluid is changed.
	Examination of the left ventricle of heart and aorta with ultrasonography.		The dilatation of the heart ventricle and aorta changes the level of reflection of ultrasound wave.
	Examination of hypertension with ultrasonography.		The density of the left ventricle is changed, which causes the change in the level of reflection of ultrasound wave.
	Examination of liver hepatitis, liver cirrhosis using ultrasonography.		The change of density of the liver reduces the intensity of reflection of ultrasound wave from the liver.
	Examination of chronic pancreatitis using ultrasonography.		The disease causes the changes in the appearance, size and density of the walls of gall bladder, ultrasound wave is reflected at the different level.
	Liver diseases are defined with		The liver density changes noticeably, the level of

	ultrasonography.		reflection of the ultrasound wave from the tissues differs.
	Thyroid gland is examined with ultrasonography.		The size of a thyroid gland changes, the ganglions occur, which leads to ultrasound wave reflecting differently from norm.
	The pancreas condition is examined with ultrasonography.		The pancreatitis changes the size of the pancreas, comparing it with the normal pancreas it is possible to notice the change of ultrasound wave reflection from the tissues.
	The gall bladder of infants is examined with ultrasonography		The cholecystitis changes the size, density of the gall bladder, the ultrasound wave is reflected differently.
	The size and condition of fetus and placenta in a uterus are examined with ultrasonography		The density of the placenta differs from other tissues therefore the ultrasound wave is clearly reflected from it.
	The brain of the infant is examined with ultrasonography.		The density of the brain make ultrasound wave clearly reflect from it.
	The heartrate of fetus in a uterus is examined with ultrasonography.		The density of the heart make ultrasound wave clearly reflect from it.
4	Antiseptic characteristic of ultrasound	The influence of energy of ultrasound wave on the body	The ultrasound has the ability to ionize water (H^+, OH^-) and to stop the process of oxidation in the cell of bacteria as a result of the phenomenon of cavitation and strong vibration, which leads to bacteria destruction.
5	Defects of aorta are defined by means of ultrasonography.	Doppler effect	It is possible to identify the repeated blood flow (backflow) in the left ventricle.
	The condition of the blood vessels of the child is defined by means of ultrasonography.		The ultrasound wave rate after the reflection from the blood flow in the vessel differs from the rate of the initial wave.
	Blood circulation in the "mother-placentae-fetus" system is examined with ultrasonography.		The ultrasound wave rate reflected from the "mother-placentae-fetus" system differs from the rate of the initial wave.
6	Sterilization of medical and surgical equipment under the pressure and high temperature.	t ^{o}C- temperature, P – pressure, atm.	Surgical instruments are sterilized under pressure of P=2 atm., t=133 ^{o}C within 20 min., rubber products at P=1.1 atm., t=133 ^{o}C within 45 min.
7	Diagnostics of heart diseases with electrocardiography (ECG)	Biological potential	Interval of time of ECG and the potential of electrocardiographic waves are changed due to the change of biological potential of heart myocardium from normal range.
	The valve closing dysfunction of heart is defined with electrocardiography (ECG)		Due to the rheumatism of heart, the interval P-Q of ECG extends, the biological potential of electrocardiographic waves decreases.
	The heart pericarditis is examined with electrocardiography (ECG)		In cardiogram, ST-segment is dome-shaped, without Q-wave, and the biological potential of QRS decreases.
	Defects of aorta are defined with electrocardiography (ECG)		The interval of ECG and the biological potential of waves are changed.
	Hypertonia is defined with electrocardiography (ECG)		The values of biological potential in the 2nd and 3rd leads and the electrical axis of heart are changed.
	Medical image on ECG before and after surgery is obligatory procedure		Examination of the patient's heart state
8	Disposition of biological membrane in two layer	Electric capacitance	In view that the plasma membrane acts as a capacitor, it is possible to measure its electric capacitance using

			electrophysiological techniques.
9	Measurement of hemoglobin of the child	Coulomb's law	Hemoglobin is separated by electrophoresis as its charge differs.
10	Assessment of defects by passing of biological potential of myocardium.	Character of passing of flow through the circulation, biological potential.	ECG intervals change sharply.
11	Examination of the condition of blood circulation in blood vessels using rheography.	Full interference, impedance, character of pass of high-speed flow through the circulation	The interference of blood vessels depends on its transaction, i.e. the interference changes at a systole and the diastole alternate. Presence of the first interference characterize blood flow rate.
12	Examination of adult internals with MRI (magnetic resonance imaging)	High-speed current electromagnetic wave	Monitoring of a wave results from excitation of water molecules by influence of high-frequency radio waves and computer processing in order to make images
	Examination of children heart vessel system's diseases, parameters of heart vessels with MRI		Monitoring of a wave results from excitation of water molecules in human body and computer processing in order to make images
13	Examination of chronic pneumonia with bronchoscopy	Full reflection, break-point, optical fiber	Doctor can see the full reflection of ray from internal organs through the optical fiber.
	Examination of stomach gastritis with fibro gastroduodenoscopy		Doctor can see the reflection of ray from stomach through the optical fiber.
	Examination of gastric ulcer with endoscopy		The reflection of ray from ulcer through the optical fiber is fixed by the doctor.
14	Sterilization of medical instruments and surgery rooms	Ultraviolet radiation (UR), diapason of UR, Photon energy	The energy of UR photons is high, so it causes chemical and biological changes.
	Vitamin "D" appeares on the skin of child; treating the rickets		Chemical and biological changes occur owing to ultraviolet radiation
15	Sterilization of surgical sutures in manufacturing condition	γ(gamma) – ray	Energy of the radiation is high
16	X-ray examination of inflammation of the lungs	Roentgen	The level of absorption of X-ray depends from the tissue condition, as it is more absorbed at pneumonia.
	Diagnosing of pericarditis with angiography		It is possible to notice fluid in the cavity of the heart with pericarditis.
	Examination of stomach gastritis with X-ray.		X-ray is absorbed more with gastric ulcer.
	Examination of intestinal tract diseases with X-ray.		Absorptivity of X-ray is high in inflammatory digestive area.
	Chronic pancreatitis is defined with CT (computer tomography)		Absorptivity of X-ray is at other level in inflammatory area.
	Examination of mammary glands with mammography		Absorptivity of X-ray is high in mammary glands tumour in 2 medical images.
	Examination of children heart vessel system's diseases, parameters of heart vessels with Pneumonography and CT		The level of absorption of X-ray depends from the tissue condition, as it is absorbed at higher level at inflammatory area.

	Mucosal relief roentgenography		The level of absorptivity of X-ray differs in different areas of different density.
	Examination of cancer with roentgenography		The density of ulcer area differs from the tissue, so the absorptivity of X-ray also differs.
17	Examination of the condition of bones	Radioactive isotope	By registering increase of isotope ^{32}P content in a bone, it is possible to notice expansion of the "blood" base there.
	Examination of the condition of thyroid gland		Is possible by defining the area of collecting of isotope ^{131}I and its volume.
18	Wound and other forms of sterilization with antiseptics	Laser	The powerful laser forms a thin layer on the wound, surface that prevents any penetration of microorganisms into the wound.
19	As a result of the impact of ionized radiation on an embryo, the central nervous system, visual system are infected.	Roentgen, r-unit and other ionizing radiation	The energy of ionizing radiation photons is high, so with their influence on organism, cells are infected.

Analyzing the Table 1, we found out that there are 61 different diagnostic inferences, related mostly to four areas (internal organs, surgical, children's diseases, obstetrics and gynecology) proved by five physical factors (mechanical, thermodynamic, electric, optical, atomic) in medical higher education institutions. For the diagnostic purposes, among physical phenomena, the most often used are ultrasonic (19 times), bio potentials (8 times), X-rays (9 times). And such physical phenomena as a turbulent stream (2 times), the phenomenon of Doppler (3 times), the sound phenomenon (4 times), information about temperature and pressure (2 times), Coulomb's law and information about electric dipole (2 times), electromagnetic wave EM of high frequency (2 times), full reflection (3 times), information about gamma and EM rays (3 times), radioisotopes have not been used so often.

Our research and the analysis of the clinical textbooks show that there is only diagnostic process considered in textbooks, there is a lack of information on using physical factors in treatment (therapy). While in modern medicine, as we know, equipment and methods of treatment are largely used on the basis of physical factors.

Discussion

Now we should proceed to the analysis of the students training technology in the process of studying the Physics, the physical phenomena and methods of their application in diagnosing. The students of medical higher education institutions study Physics in their first year. The studied scope of knowledge and the mastered level of Physics are identified in the standard training program Medical biophysics approved by Department of Education, Science and Personnel Resources of the Ministry of Health Care of the Republic of Kazakhstan. Studying and analyzing the standard program of Physics for medical higher education institutions and the curricula prepared according to the main textbooks we have come to a conclusion that it is possible to teach Physics according to specialties chosen by the students for specific purposes.

As a rule, studying medical physics begins with the analysis of the mechanism of biopotential presence in the membrane. The potential and main types of biopotential, the mechanism of their presence in a cell are studied, with respect to electrocardiogram of heart, their need and importance for medicine are explained in the course of the training. With heart electrocardiogram of the patient, registered in clinic, it is possible to define the state of heart. Having analyzed the electrocardiogram, it is necessary to pay special attention to the duration of intervals, height of electrocardiographic waves. All the mentioned data are of great importance, which is explained to the students offering them the following examples for analyzing: with heart rheumatism, the interval of P-Q of the ECG is extended, it shows the longitude of atrial contraction, i.e. shows long-term duration of such phenomenon as depolarization of cardiac muscles, together with it T biopotential, electrocardiographic wave is decreased, wave height is decreased, which is an indicator of reduction of ventricle biopotential. In these examples it can be noted that with pericarditis of heart, ST-segment has a dome-shaped form, there is no Q-wave, QRS-biopotential is decreased.

The registering such information with using different level of electrocardiographic equipment, studying medical appliances, participation of students in the ECG procedure of the patient, analyzing the physiological state of heart on the basis of ECG data, and other similar practical training attracts student's great interest, and helps to acquire the concept of biopotential. Now we should examine another physical phenomenon and its application in medicine. Hemodynamics studies the characteristics of blood that flows through vessels and the blood flow that is divided into laminar and turbulent forms. It is known from the physics that the turbulent flow has a peculiar sound. This phenomenon is widely used in medicine, particularly in diagnostics. Analyzing this flow characteristics, students should be explained its diagnostics process from the physics perspective. Firstly, students are explained the physical basis of this phenomenon. Secondly, they learn why this phenomenon is used in diagnostics.

The further discussion on this phenomenon is provided below. Measurement of blood pressure with upper arm cuff was first offered by the Italian doctor Riva Rocci in 1896. This method was further developed by the Russian doctor,

N.S. Korotkov in 1905. The method is based on auscultation (listening of a sound), i.e. feeling of the pulse sound while inflating and releasing the pressure in the cuff. In order to measure the pressure of the person, rubber cuff covered with a thin cloth is wrapped around the patient's arm. The cuff is inflated before loss of pulse (220-250 mm Hg). Then the doctor slowly releases the pressure in the cuff. The flow of blood goes up to the artery of the blood vessel, where the turbulent flow takes place, so using the phonendoscope it is possible to hear the sound of flow. It is called Korotkov's tone. The indication of the monometer at this moment is called systole. Releasing air pressure in the cuff leads to normalization of the blood flow in an artery, here the flow changes from turbulent to laminar form, therefore, there is no Korotkov's tone anymore heard from phonendoscope and the indication of monometer is called diastole. We should note that the turbulent flow is used in determining some pathological change in lungs, while diagnosing the closing of heart valves.

The students learn about the importance of physical phenomena application in medicine and diagnostics with such methods; they learn the principles of work of various medical equipment through the physical phenomena. Such pedagogical methods prompt students to conscious deep studying of physics. The afore information shows that the last stage of diagnosing leads to use of medical equipment. The data provided in Table 1 define four main clinical subjects (internal diseases, surgical diseases, children's diseases, obstetrics and gynecology), and physics disciplines are studied according to the standard program approved by the Ministry of Health Care of RK.

In the standard program of medical biophysics, six different large physical phenomena and their relation to biological subjects are considered as the biophysical phenomena. All these subjects are directly connected with clinical ones. We examined the medical equipment, applied in diagnostic and therapeutic practice of doctors and working on a basis of the different physical phenomena and physical principles. Now, connecting the use of physical factors for diagnostics (given in Table 1), and having taken them as the main direction, we systematized all factors. The physical factors applied in diagnostic practice and the medical equipment, working on the bases of these phenomena are presented in Table 2.

Table 2. The physical factors applied in diagnostic practice in relation to medical equipment

Physical factor applied in diagnosing	**Diagnostic methods**	**Characteristics of physical factor applied in diagnosing**	**Medical equipment applied in diagnosing**
Mechanical indicators			
Sound	Auscultation	Tone, pitch of sound, timber	Phonendoscope
	Phonocardiogram	Pitch of sound, its rate and tone	Phonocardiograph
	Audiometry	Rate of sound, period of vibration, amplitude, tone, timber, murmur, Bell's criteria, decibel, logarithmic graphic	"Maico MA-52" and others
	Measure of blood pressure	Turbulent blood flow, pressure, mercury	Sphygmomanometer
Ultrasound	Ultrasound examination	Wave reflection, break-point, absorption, thermal exchange, dispersion into body; mechanical, physical and chemical, biological phenomena	Ultrasound examination equipment "SSD - 360" and other types.
	Dopplerography	Wave reflection from elements of blood, frequency of the signal varies proportionally to the speed of blood flow.	Doppler echocardiographic device
	Sterilization	The rate and amplitude of wave are very high	Elimination of bacterial infections under the influence of wave. It is used for the sterilization of different medical appliances.
Pressure	Tympanometry	atmosphere pressure, wave and rate of sound	Tympanometry "AI-02" and other types
Electrical indicators			
Biological potential of the heart	Electrocardiography (ECG)	Electrical dipole, electrical dipole moment, the difference of potential, Einthoven triangle, electrical axis of the heart, ECG deflections and the indicators	Electrocardiography (ECG)

		of wave.	
Biological potential of brain	Electroencephalography	Synaptic potential, electrodes placement according to 10-20 system, wave rate, alpha, beta rates	EEG devices
Electrical impedance	Reography, electromyography, rheoencephalography	Impedance, high rate flow, amplitude of wave	"REG-04" and other reography devices
High-frequency radio wave	Magnetic resonance imaging (MRI)	Magnetic resonance influence, magnetic induction, singlemagnetic pole, radio frequency band wave, magnetic gradient, X, Y, Z – gradient coil, T – time of relaxation	"R23 Tomikon", "Image-2"
Optic indicators			
Light wave	Chemiluminescence	quantum, photochemical reaction, free radical, lipid, weak ray	Chemiluminometer CHLMS-01
	Bronchoscopy, fibrogastroendoscopy, endoscopy	Full reflection, break-point, optic fiber	
	refractometry	lens, break-point, focusing point, optic power, aberrations	Different types of refractometers
Ultraviolet ray (UR)	Sterilization	Ultraviolet rays, wavelength, energy quantum	"DB-15", "DB-30" and types
Atomic physics			
X-ray	Roentgenography, Fluorography, roengenoscopy	X-ray, thermionic brake, thermionic amplification, luminophor, energy and types of doses	Roentgen devices of different construction
	Computer tomography	x-ray tube, detection system, lateral section	Philips "Tomoscan R 7000"
Radioactivity	Radionuclide diagnostics	radioisotope, clinical radiometry, gamma-tomography, definition of biological model radioactivity, examination of radioisotope	Gamma-topograph "GT-60", Scintillation calculator "SKC-60"

Conclusions

Basing on all data obtained from the research, paying great attention of students-future doctors to the application of physical phenomena in medicine, diagnostics, in medical equipment, we attract student's interest and motivate them to conscious and deep studying of Physics. When teaching Biophysics for medical students in higher education institutions, it is necessary to consider the afore-described aspects. During the work we have investigated and analyzed only four clinical textbooks, however, there is a great number of textbooks studied in medical higher education institutions. Nevertheless, the problems we determined demand further in-depth and comprehensive studies.

The article proves the idea, that teaching Physics to medical students-future doctors for specific purpose plays a pivotal role in their future medical practice, as the effects of physical factors on a human body is important to know in order to effectively use them in the diagnostic, therapeutic, clinical laboratory practice, it implies better knowledge of the medical equipment and they are considered as the main direction of students professional assimilation, who acquire the basic fundamental laws and principles of medical physics.

Acknowledgements

None.

Conflict of Interest

None.

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Педагогічні методи професійно орієнтованої підготовки студентів медичного факультету в галузі медичної біофізики

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Анотація

Актуальність. Система вищої освіти базується насамперед на педагогічних цільових процесах, які тісно логічно пов'язані між собою. Ці процеси дозволяють навчати фахівців фундаментальним і клінічним знанням, повноцінним теоретичним і професійним навичкам і навчати їх проводити дослідницьку роботу та самостійно вдосконалювати свої знання. Це першооснови підготовки майбутніх спеціалістів.

Мета. Метою даної статті є вивчення педагогічної методики викладання медичних технологій спеціального призначення з дисципліни “Медична біофізика” у вищих медичних навчальних закладах.

Методологія. У ході роботи проведено аналіз навчальних програм та підручників з дисциплін “Внутрішні хвороби”, “Хірургічні хвороби”, “Хвороби дітей”, “Акушерство та гінекологія”, які вивчають студенти 3-5 курсів медичного факультету.

Результати. Із результатів дослідження випливає, що більшість методів діагностики, які спостерігаються в клінічних дисциплінах для студентів старших класів, базуються на фізичних явищах і законах, і ці висновки необхідно враховувати при навчанні фізики для конкретних цілей.

Висновки. Дослідження підкреслює важливість викладання фізики для студентів-медиків. Зосереджуючись на застосуванні фізичних явищ у медицині, діагностиці та медичному обладнанні, студенти мотивуються вивчати фізику.

Ключові слова: медичне обладнання; педагогіка; діагностика; біопотенціал; тренувальна програма.